USM SHORT TERM GRANT NO. 304/PPSP/6131281

COST EFFECTIVENESS ANALYSIS OF USING TWO DIFFERENT NEURO-MONITORING MODALITIES IN MANAGING SEVERE TRAUMATIC BRAIN INJURY (CESTBI) IN NEURO-ICU, HUSM, KELANTAN

Principal Investigator: DR MAZLAN ABDULLAH

BORANG USM J/P 06

BAHAGIAN PENYELIDIKAN & PEMBANGUNAN
CANSELORI
UNIVERSITI SAINS MALAYSIA

Laporan Akhir Projek Penyelidikan Jangka Pendek

1) Nama Penyelidik: Dr. Mazlan Abdullah

Nama Penyelidik-Penyelidik Lain (Jika berkaitan) : 1. Prof. Jafri Malin Abdullah
2. Prof. Syed Mohamed Al-Junid
3. Dr. Mohd Ayub Mohd Saddiq
4. Dr. Ghazaime Ghazali
5. Dr. Mohd Ismail Ibrahim
6. Dr. Zamzuri Idris

2) Pusat Pengajian/Pusat/Unit : Pusat Pengajian Sains Perubatan

3) Tajuk Projek: Cost Effectiveness Study of Using Different Monitoring Modalities In Treating Severe Traumatic Brain Injury (CESTBI).

4) (a) Penemuan Projek/Abstrak
(Perlu disediakan makluman di antara 100 – 200 perkataan di dalam Bahasa Malaysia dan Bahasa Inggeris. Ini kemudiannya akan dimuatkan ke dalam Laporan Tahunan Bahagian Penyelidikan & Pembangunan sebagai satu cara untuk menyampaikan dapatan projek tuan/puan kepada pihak Universiti).

ABSTRAK

TAJUK: ANALISA KEBERKESANAN KOS DI DALAM PENGGUNAAN DUA JENIS PERALATAN PENGAWASAN SARAF YANG PELBAGAI BAGI MERAWAT PESAKIT YANG MENGALAMI KECEDERAAN OTAK YANG TERUK DI UNIT RAWATAN RAPI SARAF, HUSM, KELANTAN

Pengenalan:

Kecederaan merupakan penyebab utama kepada kematian dan kecacatan otak dan mental. Di Malaysia, kecederaan mencatat tempat ketiga tertinggi, punca kepada

kemasukan dan kematian pesakit di hospital awam. Terdapat dua pendapat yang berbeza dalam penentuan penggunaan alat pengawasan saraf bagi pesakit yang mengalami kecederaan otak yang teruk, pengunaan sistem pengawasan saraf asas dan penggunaan sistem pelbagai pengawasan saraf yang lebih mahal kos perawatannya. Justeru jawapan kepada persoalan yang mana daripada dua sistem ini lebih efektif dan berbaloi perlu diadakan.

Objektif:

Untuk menentukan analisa keberkesanan kos di antara penggunaan peralatan pengawasan saraf yang pelbagai berbanding dengan hanya menggunakan peralatan pengawasan asas dalam merawat pesakit yang mengalami kecederaan otak yang teruk

Metodologi:

Seramai 62 orang pesakit yang mengalami kecederaan teruk di otak dan telah memenuhi kriteria yang telah di tetapkan, dipilih sewaktu mereka di masukkan ke Unit Rawatan Rapi Saraf, HUSM. Pengukuran unit kos secara makro dan mikro dilakukan keatas semua pesakit sewaktu berada di unit tersebut. Pengukuran Index Barthel selaku penilaian akhir kepada sistem perawatan ini telah dilakukan sewaktu pesakit dimasukkan ke unit rawatan rapi dan enam bulan selepas mereka dibenarkan pulang ke rumah masing-masing. Data yang diperolehi dianalisakan dengan menggunakan ujian independent t, ANCOVA, dan pengukuran ulangan ANOVA.

Keputusan:

Kajian mendapati kos pengurusan pesakit kecederaan otak yang teruk adalah lebih tinggi jika pelbagai peralatan pengawasan saraf digunakan. Perbezaan kos peralatan sebanyak RM23.74 adalah bererti jika dibandingkan dengan hanya menggunakan peralatan pengawasan asas sahaja. Perbezaan ini juga bererti jika dibandingkan di dalam kumpulan kajian setelah faktor kovariat dikawal ($p = 0.049$). Penilian Indeks

Barthel menunjukan kemajuan prestasi fizikal yang lebih baik di kalangan pesakit yang mengunakan peralatan pengawasan saraf pelbagai berbanding dengan hanya menggunakkan peralatan pengawasan saraf asas sahaja. Perbezaan sebanyak 16.92 adalah bererti (p =0.031). Pembahagi keberkesanan kos mendapati, penggunaan peralatan pengawasan saraf pelbagai hanya memerlukan RM479.29 untuk meningkatkan seunit kemajuan dalam Indeks Barthel berbanding RM629.12 jika menggunakan pengawasan asas dan perbezaan ini adalah bererti dimana nilai p yang terhasil adalah 0.031

Kesimpulan:

Walaupun penggunaan peralatan pengawasan saraf pelbagai terbukti mahal, namun ia memberi pulangan prestasi fizikal yang lebih baik kepada pesakit yang mengunakannya. Justeru, ianya adalah lebih efektif dan lebih efisen dalam perawatan pesakit yang mengalami kecederaan otak yang teruk.

Kata kunci: analisis keberkesanan kos, kecederaan otak yang teruk, peralatan pengawasan saraf

ABSTRACT

TITLE: COST EFFECTIVENESS ANALYSIS OF USING TWO DIFFERENT NEURO-MONITORING MODALITIES IN MANAGING SEVERE TRAUMATIC BRAIN INJURY (CESTBI) IN NEURO-ICU, HUSM, KELANTAN

Introduction:

Injuries are the major causes of death and disability. In Malaysia, injury remains the third leading cause of admission and death in government hospitals. There are two

schools of thought in practicing neurotrauma monitoring for patients with severe traumatic brain injury (TBI); the application of the baseline neuro-monitoring (BNM) and the use of multiple modalities neurotrauma monitoring (M3) which is very expensive. The answer of which of the two monitoring systems is more effective should be sought.

Objective:

To determine the cost effectiveness of BNM and M3 monitoring modalities in the management of severe TBI in Hospital USM (HUSM), Kelantan

Methodology:

Sixty-two patients with severe TBI admitted to Neuro-ICU, HUSM who fulfilled the predetermined criteria were purposely selected and grouped according to the surgeon's on call list. The macro and micro costing were performed on each of patient. Barthel Index was used to measure physical performance as an outcome six months after discharge. The equality of the two study groups i.e M3 and BNM, was analyzed by using independent t- test and chi square test, ANCOVA was used to analyze the different in mean total equipment cost between the group of M3 and BNM by controlling the covariate like age and severity of brain injury, and Repeated Measure ANOVA was used to look for any significant changes in the mean of Barthel Index between the group of M3 and BNM during admission and six months post discharge.

Results:

The mean total equipment cost of M3 was significantly higher than mean total equipment cost of BNM at $p = 0.049$ (mean difference of RM23.74) after controlling other variables. The mean difference in Barthel Index after six months was significant between the two groups ($p = 0.031$), patients who were treated with M3 had higher

score [63.7 (SD 30.03)] compared to those who were treated with BNM [46.83 (SD 30.36)]. However, the cost-effectiveness ratio of using M3 was significantly lower (p=0.031) with a mean of RM476.29 needed for a unit improvement in mean Barthel Index compared to RM629.12 if we used BNM

Conclusion:

Although M3 is more costly, the outcome of patients treated with M3 was better than BNM. Therefore we can conclude that the used of multiple neuro-monitoring was more cost effective than the use of only baseline neuro-monitoring in treating severe traumatic brain injury.

Keywords: cost effectiveness analysis, severe traumatic brain injury, monitoring modalities.

(b) Senaraikan Kata Kunci yang digunakan di dalam abstrak:

Bahasa Malaysia	Bahasa Inggeris
analisis keberkesanan kos	cost effectiveness analysis
kecederaan otak yang teruk	severe traumatic brain injury
peralatan pengawasan saraf	monitoring modalities

5) Output Dan Faedah Projek

(a) Penerbitan (termasuk laporan/kertas seminar)
(Sila nyatakan jenis, tajuk, pengarang, tahun terbitan dan di mana telah diterbit/dibentangkan).

1. paper for publication in Malaysia Journal of Public Health Medicine 2004 (special edition), title" Cost Effectiveness Analysis of Using Two Different Neuro-monitoring Modalities in Managing Severe Traumatic Brain Injury (CESTBI) in Neuro-ICU, HUSM, Kelantan."...the paper currently been accepted for review.

2. Eleventh National Public Health Colloquium, Research Priorities in Public Health, 21 – 22nd September 2004, The Summit Hotel, Subang USJ.

3. Malaysian Journal of Public Health Medicine, Volume 5 (Supplement 1) 2005. The Malaysian Public Health Specialist Association.

4. Fourth National Public Health Conference 2005, Galvinising Public Health Initiatives In Enhancing Population Health, 15th – 17th March 2005, Marriot Putrajaya

(b) Faedah-Faedah Lain Seperti Perkembangan Produk, Prospek Komersialisasi Dan Pendaftaran Paten.
(Jika ada dan jika perlu, sila guna kertas berasingan)

.....

.....

.....

.....

.....

.....

.....

.....

(c) Latihan Gunatenaga Manusia

i) Pelajar Siswazah:

Dr. Mohd Ismail Ibrahim – Sarjana Perubatan Masyarakat

ii) Pelajar Prasiswazah:

Tiada

iii) Lain-Lain : Salwani Remli (Pembantu Penyelidik)

6. Peralatan Yang Telah Dibeli:

Tiada

UNTUK KEGUNAAN JAWATANKUASA PENYELIDIKAN UNIVERSITI

.....

.....

.....

.....

.....

.....

.....

T/TANGAN PENGERUSI
J/K PENYELIDIKAN
PUSAT PENGAJIAN

Professor Zabidi Azhar Mohd. Hussin
Chairman of Research & Ethics Committee
School of Medical Sciences
Health Campus
Universiti Sains Malaysia
16150 Kubang Kerian,
KELANTAN, MALAYSIA.

Eleventh National Public Health Colloquium

Research Priorities in PUBLIC HEALTH ?

Date :
21 - 22nd September 2004

Venue :
The Summit Hotel, Subang USJ

Aventis

Organised by :
- Department of Comunity Health, Faculty of Medicine, UKM.
- Chapter of Public Health Medicine, The Academy of Medicine of Malaysia.
- Persatuan Doktor Pakar Kesihatan Awam Malaysia.

aktiviti enzim kolinesterase kumpulan terdedah, 62.5% pada nilai tahap tinggi (> 8500). Berdasarkan keputusan yang diperolehi, didapati terdapat penurunan tahap aktiviti enzim kolinesterase tetapi tidak dapat dibuktikan melalui ujian statistik. Ujian Kolerasi Pearson terhadap tempoh pendedahan (tahun dan jam/hari) tidak disignifikan dengan tahap aktiviti enzim kolinesterase (nilai p= 0.975 dan p= 0.204). Kumpulan terdedah diwajibkan memakai alat perlindungan keselamatan diri (PPE) semasa mengendalikan kerja harian mereka. Terdapat 14 simptom utama yang dihadapi oleh sebahagian daripada kumpulan terdedah. Simptom paling utama adalah masalah penghadaman ialah 25 orang (62.5%) dan paling kurang adalah seorang (2.5%) masing-masing pada symptom loya dan citit birit. Daripada ujian chi-square (X2) mendapati masalah sukar tidur pada waktu malam sahaja (p=0.041) yang signifikan dengan tahap aktiviti enzim kolinesterase. Sebagai kesimpulan, pendedahan kepada pestisid akan menyebabkan penurunan tahap aktiviti enzim kolinesterase dan kajian lanjut perlu diteruskan.

SC2SP4

PATTERN OF ROAD TRAFFIC ACCIDENT IN KELANTAN (1997-2003)

Azmani W, Mohamed Rusli A, Aziz Al Safi, Hashim M

Jabatan Perubatan Masyarakat, Universiti Sains Malaysia, Kubang Kerian, Kelantan.
Ibu Pejabat Kontinjen (IPK) Polis, Kelantan

Introduction: Road traffic accidents (RTAs) are among the ten cause of death in Malaysia. It is a Shocking fact that RTAs killed more people in other developing countries too, every year, than war and disease. More than 20 milion people are severly injured or killed on the world's roads each year.
Objective: The aim of this study was to determine the mortality and morbidity pattern of road traffic accidents from 1997 to 2003 in Kelantan
Methods: The retrospective study was conducted in which the relevant data were collected by reviewing the records on road traffic accident (RTA) from the year 1997 to 2003. The records included information about monthly data such as number of fatal and non fatal accidents and distributionof accidentsby year. Data gathered were input into SPSS version 11 and Microsoft Excell and analyzed using decomposition method to explore the seasonality and simple linear regression to explore the trend in time series analysis.
Result: There were 40,452 people involved in RTA over the 7 years period. The highest percentage of accidents (17.7%) occurred in 2003, while the lowest percentage of accidents (12.1%) occurred in 1998. Trend of RTA increased significantly by month (β= 2.079) however there was no seasonal pattern observed.
Conclusion: Road traffic accidents are still a major public health problem. There were significant trend but no consistent similarities and seasonal pattern (by month) of road traffic accident.

SD1SP1 ✓

COST EFFECTIVENESS ANALYSIS OF USING DIFFERENT MONITORING MODALITIES IN TREATING SEVERE TRAUMATIC BRAIN INJURY (CESTBI)

Mohd Ismail I[1], Mazlan A[1], Naing L[2], Jafri Malin A[3], Syed Mohamed AL[4]

[1] Department of Community Medicine, School Of Medical Sciences, USM
[2] School of Dental Sciences, USM
[3] Neuroscience Unit, School of Medical Sciences, USM
[4] Department of Community Health, Faculty of Medicine, UKM

Introduction: Injuries are the major causes of death and disability. In Malaysia, injury remains the third leading cause of admission and death in government hospitals. There are two schools of thought in practicing neurotrauma monitoring for patients with severe traumatic brain injury (TBI); the application of the baseline neuro-monitoring (BNM) and the use of multiple modalities neurotrauma monitoring (M3) which is very expensive. The answer of which of the two monitoring systems is more efficient and worth doing should be sought.
Objective: To determine the cost effectiveness analysis between BNM and M3 monitoring modalities in the management of severe TBI
Methodology: 54 patients with severe TBI admitted to Neuro ICU, USM who fulfilled the predetermined criteria were selected using systematic random sampling. The macro and micro costings were performed on each of patient. Barthel's index score was used to measure physical performance as an outcome six

months after discharge. The analyses used were the Independent t- test, ANCOVA, and Repeated Measure ANOVA.
Results: The mean total equipment cost of M3 was significantly higher at $p<0.05$ (mean difference of 11.084) after controlling other variables. However, the cost per outcome (mean Barthel's Index score) of M3 was significantly lowered ($p=0.031$) with a mean of 221.06.
Conclusion: Athough M3 is more costly, the outcome of patients treated with M3 was better than that of BNM.

SD1SP2
A RETROSPECTIVE STUDY OF PHYSIOTHERAPY SERVICES AND REFERRAL PATTERN AMONG PHYSICIANS IN GENERAL HOSPITAL KUALA LUMPUR.
Ayiesah, R.[1] & Zaleha, M.I.[2]

[1]Physiotherapy Programme, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur.
[2]Department of Community Health, Medical Faculty, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz,50300 Kuala Lumpur.

The aim of this study is to identify patients' referral pattern by physicians to the Physiotherapy Unit among in-patients in General Hospital Kuala Lumpur (GHKL). This retrospective data was taken from the report file of Physiotherapy Department, GHKL. Study subjects consist of 6,503 in-patients that were referred to physiotherapy services in the year 2003. Descriptive statistics was used to evaluate the variables using frequency count. Study results showed that a total of 4,273 (66.2%) male patients and 2,177 (33.8%) female patients were referred to physiotherapy services, GHKL. Majority of the referred patients were Malays (56.2%, n = 3,627) with age between 40 to 70 years old (50.3%, n = 3177). Most of the patients received their treatment between 3 days and 2 weeks of duration (78.5%, n = 5,065). The largest referral was from the Orthopaedic Unit (34.6%, n = 2,249), followed by ICU/CCU/CRW Unit (18.3%, n = 1,189) and Neurology Unit (17.4%, n = 1,134). Majority of the patients referred have medical (21.6%, n = 1,394) and neurology (20.1%, n = 1,298) diagnosis. A large number of patients received more than one treatment modality per treatment session. The common treatment modality given is exercise therapy (98.6%, n = 6,411), followed by chest therapy (94.9%, n = 4,130) and either modalities for neurological therapy, mobilization or hydrotherapy (96.9%, n = 127). Among patients age 60 years and above, majority of orthopaedic/non-specific diagnosis referred (88.6%, n = 302/341) was due to trauma; majority of neurology diagnosis referred (97.4%, n = 333/342) was due to CVA; majority cardiorespiratory diagnosis referred (97.6%, n = 360/369) was due to COAD/CCF; whilst majority of medicine/circulatory diagnosis referred (31.1%, n = 173/557) was due to cancer. It can be concluded that throughout the year 2003, a large number of patients referred were males, Malays, and age between 40 to 70 years old. The most frequent treatment length was between 3 days to 2 weeks and the largest referral came from Orthopaedic Unit. Most of the patients referred were diagnosed with medicine and neurology conditions. Exercise therapy and chest physiotherapy were the largest treatment modalities during the first and second physiotherapy interventions. The main reason for orthopaedic/non-specific, neurology, cardiorespiratory and medicine/circulatory patient referrals was because of trauma, CVA, COAD/CCF and cancer, respectively.

SD1SP3
CAPACITY OF PUBLIC HEALTH LAWS ENFORCEMENT IN THE STATE OF SELANGOR
Sh. Ezat Alkaff; Syed Mohamed Aljunid

Community Health Department, UKM

A cross sectional study initiated among the public health inspectors in state of selangor in july 2003 using a self administered questionnaire and universal sampling with the purpose to determine the capacity of public health laws enforcement and factors influencing it. A total of 99 respondents from the health districts offices and 100 respondents from the local municipal health departments participated in this study. It was found that the level of enforcement is generally low in all the units except for two units; the food unit and sanitary and higence units. Factors found to influence the capacity to enforce are the units' the respondents work and the length of service being in the unit. Further analyis using multiple logistic regression, showed that respondents from the Food Unit

MALAYSIAN JOURNAL OF

PUBLIC HEALTH MEDICINE

ISSN: 1675-0306 Volume 5 (Supplement 1) 2005

Official Publication of the

THE MALAYSIAN PUBLIC HEALTH SPECIALIST ASSOCIATION

This study also finds that there were significant differences between WBGT before and after work. Pearson Correlation Test showed that there was a significant correlation between WBGTin and heart rate before and after work. In conclusion, WBGTin of this foundry plant is above the limit stated by ACGIH TLV (>28 °C)[1]. To avoid heat stress among the workers, it is suggested that more control programme should be conducted.

Key words: Heat Stress, Physiological Changes, Petrochemical Industry

P21

KNOWLEDGE OF NEONATAL JAUNDICE AMONG NURSING STAFFSAT KUALA KRAI DISTRICT HEALTH OFFICE

Noor Aini Ibrahim[1], Hasniza Abdullah[2] and Hasbullah Abdul Rahman[2]
[1] Pejabat Kesihatan Kuala Krai, Kelantan
[2] Pejabat Kesihatan Pasir Mas, Kelantan

Introduction: Kuala Krai district health office has shortfall in quality for severe neonatal jaundice where 45 cases were treated for severe neonatal jaundice from January to December, 2003. Infants at risk of severe hyperbilirubinemia should be identified and observed closely by nursing staffs to avoid complication of kernicterus.

Aim: To determine the knowledge of neonatal jaundice among nursing staff at Kuala Krai District Health Office.

Methods: The study was a cross-sectional study conducted in July, 2004 among 30 nursing staffs at Kuala Krai District Health Office selected by random sampling. Data was collected using standardized questionnaires comprising of 4 socio-demographic and 21 knowledge questions obtained from Quality Assurance Manual by Maternal and Child Health Unit, Ministry of Health, 1993. Statistical tests used included chi-square and independent t-test. Median cut off points (67%) was used to categorize knowledge into good and poor knowledge.

Results: The mean age of nursing staffs were 32 years old (SD 10.3). The mean duration of services was 8 years old (SD 10.5). Forty percent of them were staff nurses and 60% were community nurses. Majority (87%) of nursing staffs were married. There was a significant difference on knowledge between staff nurses and community nurses (p value < 0.05). Eighthy three percent of staff nurses had a good knowledge compared to only 33% of community nurses. Independent t-test showed there was significant difference in mean duration of services between staff nurses and community nurses (p value < 0.05), with mean difference of 13 years, and 95% Confidence interval 6 years to 19 years. Staff nurses had higher mean duration of services.

Conclusion: Staff category and duration of services determined the knowledge of neonatal jaundice in Kuala Krai District Health Office.

Keywords: knowledge, neonatal jaundice, nursing staffs, duration of services

P22

COST EFFECTIVENESS ANALYSIS OF USING DIFFERENT MONITORING MODALITIES IN TREATING SEVERE TRAUMATIC BRAIN INJURY IN HOSPITAL USM, KELANTAN (CESTBI)

Mohd Ismail I[1], Mazlan A[1], Naing L[2], Jafri Malin A[3], AlJunid S[4]
[1] Department of Community Medicine, School Of Medical Sciences, USM
[2] School of Dental Sciences, USM
[3] Department of Neuroscience, School of Medical Sciences, USM
[4] Department of Community Health, Faculty of Medicine, UKM

Introduction:
Injuries are the major causes of death and disability. In Malaysia, injury remains the third leading cause of admission and death in government hospitals. There are two schools of thought in practicing neurotrauma monitoring for patients with severe traumatic brain injury (TBI); the application of the baseline neuro-monitoring (BNM) and the use of multiple modalities neurotrauma monitoring (M3) which is very expensive. The answer of which of the two monitoring systems is more efficient and worth doing should be sought.

Objective:
To conduct the cost effectiveness analysis of BNM and M3 monitoring modalities in the management of severe TBI

Methodology:
Sixty-two patients with severe TBI admitted to Neuro-ICU, HUSM who fulfilled the predetermined criteria were selected using systematic random sampling. The macro and micro costing were performed on each of patient. Barthel Index was used to measure physical performance as an outcome six months after discharge. The analyses used were the Independent t- test, ANCOVA, and Repeated Measure ANOVA.

Results:
The mean total equipment cost of M3 was significantly higher at p=0.049 (mean difference of RM21.74) after controlling other variables. The mean difference in Barthel Index was significance between the two groups, patients that were treated with M3 had higher score [63.75 (30.03)] compared to those who were treated with BNM [46.83 (30.36)]. However, the cost-effectiveness ratio of using M3 was significantly lowered (p=0.031) with a mean of RM476.29 was needed to increase a unit improvement in mean Barthel Index compared to RM629.12 if we used BNM

Conclusion:
Although M3 is more costly, the outcome of patients treated with M3 was better than that of BNM. Therefore we can conclude that the used of M3 was more cost effective than the use of only BNM in treating severe traumatic brain injury.

P23

RISK FACTORS ASSOCIATED WITH CARDIOVASCULAR DISEASE AMONG A SAMPLE OF ADULTS 40 YEARS OLD AND ABOVE

Zaitun Y and Eng KL
Department of Nutrition & Health Sciences
Faculty of Medicine & Health Sciences
Universiti Putra Malaysia
43400 Serdang, Selangor

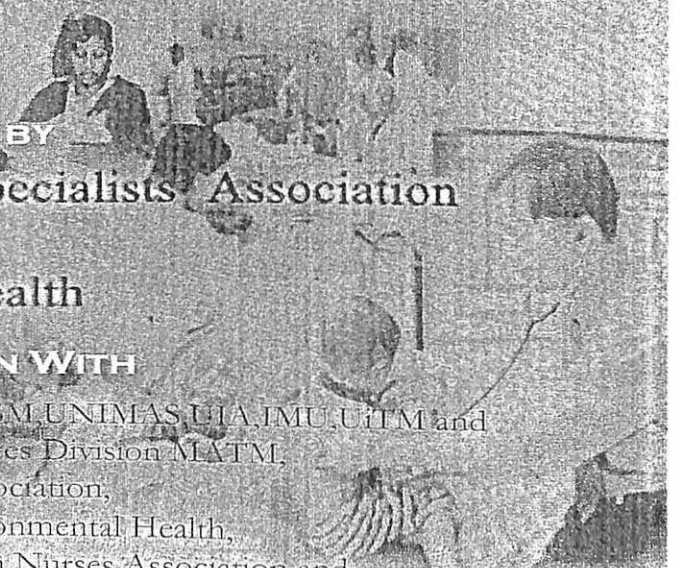
The objective of this study was to determine the prevalence of risk factors associated with cardiovascular disease (CVD) among a sample of adults 40 years and above in Butterworth, Pulau Pinang. A total of 80 respondents (45% males and 55% females) who met selection criteria participated in the study. Data collected includes socio-demographic and health characteristics, lifestyle factors and frequency of food intake, using a set of questionnaire. Anthropometric and blood pressure measurements, and biochemical parameters were collected using appropriate instruments and standard procedures. The CVD risk factors included in this study were age, family history, smoking, alcohol consumption, nutritional practices, physical activity, obesity, hypertension, diabetes mellitus and hypercholesterolemia. The result of the study showed that 53.8%of the respondents were between 40 to 44 years. Majority (77.5%) were Chinese and 66.3% had 11 to 15 years of formal education. About 65.0% had family income of between RM3000 to RM7000 per month. A total of 87.6% of the respondents perceived their health as good to excellent. About 4% of them were currently smoking and alcohol consumption was reported by about 41% of the respondents. Frequency of food intakes revealed low consumption of fruits and vegetables on a daily basis. Ever doing exercise in the past week was reported by 66.3% of the respondents. The mean body mass index (BMI) was 24.1± 3.7 kg/m^2 and 25.0% were overweight and 8.8% were obese. Central obesity were observed in 23.8% of the respondents. Based on the classification of systolic BP greater than 140 mmHg and/or diastolic BP greater than 90 mmHg, 16.3% of the respondents were considered to be hypertensive. The mean total blood glucose level was 3.9±1.3 mmol/L and 2.5% of the respondents had blood glucose level higher than 7.8 mmol/L. The average total blood cholesterol level was 4.0±1.0 mmol/L and 2.5% of the respondents were considered to be hypercholesterolemic (>5.2mmol/L). Pearson correlation test showed a significant correlation only between age of respondent and waist circumference and not with the other anthropometric or blood variables. Based on seven risk factors associated with CVD, 40.8% had at least one risk factor and only 6.6% had three or more risk factors. Therefore, it is recommended that intervention strategies should be formulated and implemented to

FOURTH NATIONAL PUBLIC HEALTH CONFERENCE 2005

"GALVANISING PUBLIC HEALTH INITIATIVES IN ENHANCING POPULATION HEALTH"

15TH - 17TH MARCH 2005
MARRIOTT PUTRAJAYA

GUEST OF HONOUR
YAB DATO' SRI MOHD NAJIB TUN HJ ABDUL RAZAK
DEPUTY PRIME MINISTER OF MALAYSIA



ORGANIZED BY
The Malaysian Public Health Specialists' Association
and
Ministry of Health

IN COLLABORATION WITH
Public Health Department of UKM,UM,UPM,USM,UNIMAS,UIA,IMU,UiTM and Academy ofMedicine, Health Services Division MATM,
Malaysia Medical Association,
Malaysian Association of Environmental Health,
Malaysian Dental Association, Malaysian Nurses Association and
Malaysian Medical Assistant Association

Bayer HealthCare ORACLE niaga

MANUSKRIP

ABSTRACT

TITLE: COST EFFECTIVENESS ANALYSIS OF USING TWO DIFFERENT NEURO-MONITORING MODALITIES IN MANAGING SEVERE TRAUMATIC BRAIN INJURY (CESTBI) IN NEURO-ICU, HUSM, KELANTAN

Mohd Ismail I[1], Mazlan A[1], Naing L[2], Jafri Malin A[3], AlJunid S[4]

[1] Department of Community Medicine, School Of Medical Sciences, USM
[2] School of Dental Sciences, USM
[3] Department of Neuroscience, School of Medical Sciences, USM
[4] Department of Community Health, Faculty of Medicine, UKM

Introduction:
Injuries are the major causes of death and disability. In Malaysia, injury remains the third leading cause of admission and death in government hospitals. There are two schools of thought in practicing neurotrauma monitoring for patients with severe traumatic brain injury (TBI); the application of the baseline neuro-monitoring (BNM) and the use of multiple modalities neurotrauma monitoring (M3) which is very expensive. The answer of which of the two monitoring systems is more effective should be sought.

Objective:
To determine the cost effectiveness of BNM and M3 monitoring modalities in the management of severe TBI in Hospital USM (HUSM), Kelantan

Methodology:
Sixty-two patients with severe TBI admitted to Neuro-ICU, HUSM who fulfilled the predetermined criteria were purposely selected and grouped according to the surgeon's on call list. The macro and micro costing were performed on each of patient. Barthel Index was used to measure physical performance as an outcome six months after discharge. The equality of the two study groups i.e M3 and BNM, was analyzed by using independent t- test and chi square test, ANCOVA was used to analyze the different in mean total equipment cost between the group of M3 and BNM by controlling the covariate like age and severity of brain injury, and Repeated Measure ANOVA was used to look for any significant changes in the mean of Barthel Index between the group of M3 and BNM during admission and six months post discharge.

Results:
The mean total equipment cost of M3 was significantly higher than mean total equipment cost of BNM at $p = 0.049$ (mean difference of RM23.74) after controlling other variables. The mean difference in Barthel Index after six months was significant between the two groups ($p = 0.031$), patients who were treated with M3 had higher score [63.7 (SD 30.03)] compared to those who were treated with BNM [46.83 (SD 30.36)]. However, the cost-effectiveness ratio of using M3 was significantly lower ($p=0.031$) with a mean of RM476.29 needed for a unit improvement in mean Barthel Index compared to RM629.12 if we used BNM

Conclusion:
Although M3 is more costly, the outcome of patients treated with M3 was better than BNM. Therefore we can conclude that the used of multiple neuro-monitoring was more

cost effective than the use of only baseline neuro-monitoring in treating severe traumatic brain injury.

Keywords: cost effectiveness analysis, severe traumatic brain injury, monitoring modalities.

INTRODUCTION

Management of severe traumatic brain injury may be very complex with interaction of multiple variables such as intracranial pressure (ICP), cerebral perfusion pressure (CPP), arterial carbon dioxide tension (PaCO2) and mean arterial pressure (MAP) (Ghajar *et al*, 1995, Matta & Menon, 1996). Even though the use of ICP monitoring has grown to become a standard technique in the management of severely head injured patients, the present of other modalities like Transcranial Doppler Ultrasonography, Jugular Venous Oximetery (White & Baker, 2002), Cerebral Oxygen Monitoring (Schell & Cole, 2000) and others has improved the final outcome of the patient with traumatic brain injury despite of the present of the skillful and expert personnel that guide the treatment toward the better quality of life of the patient. However, these will either directly or indirectly increase the total cost of the management of the patient. During this time, costs for medical and surgical supplies were greatest for persons with severe brain injuries and those who eventually spent longer time in the Neuro-Intensive Care Unit. Additionally, individuals with more severe injuries received the highest pharmacy bills (Mayer *et al.* (2003). There are many ways to assess the outcome of patient following severe traumatic brain injury (Whyte & Rosenthal, 1998). Apart from GOS and DRS, the Barthal Index scoring system also can be used to assess the outcome of the patients with severe traumatic brain injury. There were two schools of thought in practicing neurotrauma monitoring for patient with severe traumatic brain injury in HUSM. Firstly, the application of the baseline neuro-monitoring (BNM) which is mainly focusing on ICP monitoring was believed to be efficient enough to assist in achieving the maximum outcome of the treatment. The other who uses multiple modalities monitoring (M3) like Transcranial Doppler Ultrasonography, Jugular Venous Oximetery and Cerebral Oxygen Monitoring on top of ICP monitoring, believes that BNM was not sufficient enough in detecting adverse brain condition that may result in poorer medical outcome and subsequently result in higher direct medical expenditures and indirect cost.The answer whether those M3 are worth doing or BNM is efficient enough in clinical management of patient with severe traumatic brain injury should be sought out in order a proper policy or policy adjustment could be made for the best accessibility and equity in the patient care.

METHODOLOGY

The study was conducted in Hospital Universiti Sains Malaysia (HUSM), Neoru-Intensive Care Unit (ICU), Kota Bharu, Kelantan from January 2003 till December 2003. It was a cost-effectiveness analysis study (prospective cohort). In this study, the costs of different monitoring in treating patients with severe traumatic brain injury play a major concern. Barthel Index was used as an outcome measurement because it was more comprehensive method and has been recommended as a standard measure of physical

disability to those who had neurological deficit (Laura *et al*, 1998). It consists of the series of physical performance that need to be done by patients on admission and six months post discharge from neuro-ICU. The costs of the treatment were measured by using budget information for the financial year 2003 which consisted of recurrent cost and capital cost started from the day of admission till the patients were discharged from the neuro-ICU. Only the direct provider costs were calculated in this study. The indirect costs were presumed equal in both groups because the study was conducted at same place and using similar facilities. The patients who were sustained traumatic brain injury without any major orthopedic or surgical problems which GCS at 8 and below were recruited as sample of the study. Those who already had previous history of traumatic brain injury or organic brain injury and had underlying chronic medical illness like diabetes and hypertension were excluded in this study. The sample size was measured by using formula of different between two means and the patients were selected by using systematic random sampling. All the data that were obtained via macro and micro costing form as well as Barthel Index form were analyzed using SPSS version 10.0.

RESULT

There were 62 patients who sustained severe traumatic brain injury recruited in this study. Thirty-three of them were monitored by using multiple modalities of neuro-monitoring (M3 and thirty of them were put baseline neuro-monitoring (BNM) only. Majority of the cases were male (92.0%) and only 8.0% of them were female. Road traffic accident (RTA) was found to be the most common cause of brain injury followed by fall and fighting. Table 1 shows that only the mean Barthel index measured at six months post treatment was significantly difference between the two groups. Others parameters were found not to be significantly difference. Equipment cost plays a major role in this study. Each techniques of monitoring, either by using M3 or only BNM will reveal different costing value and this difference will give the result in choosing a better technique in managing the patients with severe traumatic brain injury. In this study, age and severity of illness which were level of consciousness presented by GSC and Marshall Index score were consider as cofounders.
By using ANCOVA, the covariates were controlled and the means difference in equipment cost between the two groups was still significance at p equal to 0.049 (Table 2).

Table 1: Characteristic of respondents in both groups

Variables	GROUP 1 (M3)	GROUP 2 (BNM)		
	Mean (SD)	Mean (SD)	Mean Difference	[a] p value
Age (Year)	34.2 (20.15)	33.4 (18.86)	0.8	0.875
[b] GCS	6.6 (1.37)	6.0 (1.45)	0.6	0.101
[b] Marshall Index	2.8 (0.81)	3.1 (0.96)	0.3	0.259
[c] Barthel's Index	63.7 (30.03)	46.8 (30.36)	16.9	0.031

Length of stay (Days)	14.4 (6.61)	12.4 (6.13)	2.0	0.221

Note: [a] independent t test (equal variance was assumed), [b] Measure during admission, [c] Measure at 6 month

Table 2: ANCOVA to determine the mean total equipment cost differences when age and severity of illness; GSC and Marshall Index were controlled

Group of study	Mean [a] (SD)	p value	Adj. mean [b] (95% CI)	F stat (df)	p value
M3	109.9 (50.17)	0.040	108.9 (91.90-126.02)	(3.07, 1)	0.049
BNM	86.2 (42.47)		87.2 (69.54-104.80)		

Note: [a] Independent t test

[b] Adjusting mean using ANCOVA (adjusting for age and severity of illness; GCS and Marshall Index)

According to result presented in Table 3, there was no significance changed in Barthel index at time of admission because all of them were ventilated. After six months post treatment in neuro-ICU, the mean Bathel index was significantly difference between the study groups.

Table 3: Repeated Measure ANOVA to compare the change of Barthel Index between two groups

Group / Time	At Admission Mean (SD)	At six months Mean (SD)	F stat (df)	P value [a]
M3	0.00 (0.0)	63.75 (30.03)	4.86 (1)	0.031
BNM	0.00 (0.0)	46.83 (30.36)		

Note: [a] Null hypothesis; The Barthel Index change is not different between two study groups

Cost-effectiveness analysis was done to the mean provider cost. The ratio of mean provider cost to mean Barthel index was calculated for each patient in both groups.

Table 4: Cost-Effectiveness Ratio of treating severe traumatic brain injury with different group of neuro-monitoring modalities

Group of Study	Provider Cost Per Patient (RM) Mean (SD)	Barthel Index Change (Outcome) Mean (SD)	Cost-Effectiveness Ratio (Cost / Outcome)	p value [a]
M3	30,363.6 (23,405.15)	63.75 (30.03)	476.29	0.031
BNM	29,461.6 (18,835.30)	46.83 (30.36)	629.12	

Note: [a] independent t test

Table 4 shows that the cost-effectiveness ratio for patient who was treated with multiple neuro-monitoring is RM 476.29 per unit increase of mean Barthel index while in BNM group, the cost-effectiveness ratio is RM 629.12 per unit increase of mean Barthel index changed. The mean different of cost effectiveness ratio was significance between the two groups.

DISCUSSION

This study had shown that majority of the patients who had severe traumatic brain injury were male, only 8% of them were female. Most of them sustained injury through road traffic accident. Their characteristics (age, GCS score, Marshall Index score, length of stay and gender) were comparable in between the groups. It was purposely conducted to look at the provider cost in managing patient with severe traumatic brain injury. The statistical analysis (independent-t test) of mean provider costs showed that there were no significance differences in mean score of all categories of provider cost (building, operation and maintenance, salary, imaging, laboratory, drugs and consumables item) except for the mean equipment cost. Controlling the covariate factors was very important to ensure that the mean difference in equipment cost was not been influenced by others variables. Analysis of covariance (ANCOVA) revealed that after controlling the covariates, the difference in total mean equipment cost still remain significance. It showed that the cost of treating patient by using multiple neuro-monitoring (M3) was higher as compared to those who were only managed with baseline neuro-monitoring (BNM).

Repeated Measure ANOVA shows that with the application of M3, the ability of the patients to recover from the neurological insult was higher than those who were only managed by using BNM only. The physical improvement was shown by the significance difference in Barthel Index six months post-treatment in Neuro-ICU.

The cost of managing patient with severe traumatic brain injury was expensive.It was once again proven via this study that revealed the mean total provider cost of a patient that had been monitored by M3 and only BNM were RM30,363.6 and RM29,461.6 respectively and it was not significance difference in between study groups. However, the cost effectiveness ratio (ratio between provider cost and mean outcome) of treating severe traumatic brain injury was RM476.26 in M3 and RM629.12 if we use BNM and the difference of RM146.83 per patient was statistically significance ($p = 0.031$).This analysis presents for the first time evidence suggesting that the used of M3 for patient with severe traumatic brain injury offers a cost effective means of reducing the risk of complication and improving health performance especially in recovery from neurological deficit. Therefore the policy of treating severe traumatic brain injury needs to be revised so that the equity and accessibility of these modern and sophisticated facilities can be achieved. The protocols of neurological management in Neuro-ICU also need to be reviewed so that it can fit with the current need. Detail financial assessments needed for the provider to make judgment in expanding this services.

ACKNOWLEDGEMENT

Special thank to The School of Medical Sciences, Hospital USM and The Research and Ethics Committee and The Biomedical and Health Science Committee for approving the short term research grant for this study.

REFERRENCES

Ghajar, J., Hariri, R.I., Narayan, R.K., Iacono, L.A., Firlik, K. and Paterson, R.H. (1995). Survey of critical care m,anagement of comatose, head-injured patients in the United State. *Critical Care Medicine* **23**, 560-567.

Laura, E.L., Perrigrew, B.Sc.,Lindsay Wilson, J.T., and Graham, M.T. (1998). Assessing disability after head injury: improved use of the Glasgow Outcome Scale. *Journal Neurosurgery* **89**, 939-943.

Matta, B. and Menon, D. (1996). Severe head injury in the United Kingdom and Ireland: a survey of practice and implications for management. *Critical Care Medicine* **24**, 1743-1748.

Mayer, N.H., Pelenskey, J. John White, J. and Fiedler-Sheppard, R. (2003). Characterization and correlates of medical and rehabilitation charges of traumatic brain injury during acute rehabilitation hospitalization. *Archives of Physical Medicine and Rehabilitation* **84**, 242-248.

Schell, R.M. and Cole, D.J. (2000). Cerebral Monitoring: Jugular Venous Oximetry. *Anesthesia Analg* **90**, 559-566.

White, H. and Baker, A. (2002). Continuous Jugular Venous Oximetry in the neuro-intensive care unit: a brief review. *Canadian Journal of Anesthesia* **49**, 623-629.

Whyte, J. and Rosenthal, M. (1998). Rehabilitation of the patient with head injury. In J.A. Delisa (Ed.). *Rehabilitation Medicine: Principles and Practice*. Philadelphia: J.B. Lippincott Publishing.

LAPORAN AKHIR

- COST EFFECTIVENESS ANALYSIS OF USING TWO DIFFERENT NEURO-MONITORING MODALITIES IN MANAGING SEVERE TRAUMATIC BRAIN INJURY (CESTBI) IN NEURO-ICU, HUSM, KELANTAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRAK

TAJUK: ANALISA KEBERKESANAN KOS DI DALAM PENGGUNAAN DUA JENIS PERALATAN PENGAWASAN SARAF YANG PELBAGAI BAGI MERAWAT PESAKIT YANG MENGALAMI KECEDERAAN OTAK YANG TERUK DI UNIT RAWATAN RAPI SARAF, HUSM, KELANTAN

Pengenalan:

Kecederaan merupakan penyebab utama kepada kematian dan kecacatan otak dan mental. Di Malaysia, kecederaan mencatat tempat ketiga tertinggi, punca kepada kemasukan dan kematian pesakit di hospital awam. Terdapat dua pendapat yang berbeza dalam penentuan penggunaan alat pengawasan saraf bagi pesakit yang mengalami kecederaan otak yang teruk, pengunaan sistem pengawasan saraf asas dan penggunaan sistem pelbagai pengawasan saraf yang lebih mahal kos perawatannya. Justeru jawapan kepada persoalan yang mana daripada dua sistem ini lebih efektif dan berbaloi perlu diadakan.

Objektif:

Untuk menentukan analisa keberkesanan kos di antara penggunaan peralatan pengawasan saraf yang pelbagai berbanding dengan hanya menggunakan peralatan pengawasan asas dalam merawat pesakit yang mengalami kecederaan otak yang teruk

Metodologi:

Seramai 62 orang pesakit yang mengalami kecederaan teruk di otak dan telah memenuhi kriteria yang telah di tetapkan, dipilih sewaktu mereka di masukkan ke Unit Rawatan Rapi Saraf, HUSM. Pengukuran unit kos secara makro dan mikro dilakukan keatas semua pesakit sewaktu berada di unit tersebut. Pengukuran Index Barthel selaku penilaian akhir kepada sistem perawatan ini telah dilakukan sewaktu pesakit dimasukkan ke unit rawatan

rapi dan enam bulan selepas mereka dibenarkan pulang ke rumah masing-masing. Data yang diperolehi dianalisakan dengan menggunakan ujian independent t, ANCOVA, dan pengukuran ulangan ANOVA.

Keputusan:

Kajian mendapati kos pengurusan pesakit kecederaan otak yang teruk adalah lebih tinggi jika pelbagai peralatan pengawasan saraf digunakan. Perbezaan kos peralatan sebanyak RM23.74 adalah bererti jika dibandingkan dengan hanya menggunakan peralatan pengawasan asas sahaja. Perbezaan ini juga bererti jika dibandingkan di dalam kumpulan kajian setelah faktor kovariat dikawal ($p = 0.049$). Penilian Indeks Barthel menunjukan kemajuan prestasi fizikal yang lebih baik di kalangan pesakit yang mengunakan peralatan pengawasan saraf pelbagai berbanding dengan hanya menggunakkan peralatan pengawasan saraf asas sahaja. Perbezaan sebanyak 16.92 adalah bererti ($p = 0.031$). Pembahagi keberkesanan kos mendapati, penggunaan peralatan pengawasan saraf pelbagai hanya memerlukan RM479.29 untuk meningkatkan seunit kemajuan dalam Indeks Barthel berbanding RM629.12 jika menggunakan pengawasan asas dan perbezaan ini adalah bererti dimana nilai p yang terhasil adalah 0.031

Kesimpulan:

Walaupun penggunaan peralatan pengawasan saraf pelbagai terbukti mahal, namun ia memberi pulangan prestasi fizikal yang lebih baik kepada pesakit yang menguhakannya. Justeru, ianya adalah lebih efektif dan lebih efisen dalam perawatan pesakit yang mengalami kecederaan otak yang teruk.

Kata kunci: analisis keberkesanan kos, kecederaan otak yang teruk, peralatan pengawasan saraf

ABSTRACT

TITLE: COST EFFECTIVENESS ANALYSIS OF USING TWO DIFFERENT NEURO-MONITORING MODALITIES IN MANAGING SEVERE TRAUMATIC BRAIN INJURY (CESTBI) IN NEURO-ICU, HUSM, KELANTAN

Introduction:

Injuries are the major causes of death and disability. In Malaysia, injury remains the third leading cause of admission and death in government hospitals. There are two schools of thought in practicing neurotrauma monitoring for patients with severe traumatic brain injury (TBI); the application of the baseline neuro-monitoring (BNM) and the use of multiple modalities neurotrauma monitoring (M3) which is very expensive. The answer of which of the two monitoring systems is more effective should be sought.

Objective:

To determine the cost effectiveness of BNM and M3 monitoring modalities in the management of severe TBI in Hospital USM (HUSM), Kelantan

Methodology:

Sixty-two patients with severe TBI admitted to Neuro-ICU, HUSM who fulfilled the predetermined criteria were purposely selected and grouped according to the surgeon's on call list. The macro and micro costing were performed on each of patient. Barthel Index was used to measure physical performance as an outcome six months after discharge. The equality of the two study groups i.e M3 and BNM, was analyzed by using independent t- test and chi square test, ANCOVA was used to analyze the different in

mean total equipment cost between the group of M3 and BNM by controlling the covariate like age and severity of brain injury, and Repeated Measure ANOVA was used to look for any significant changes in the mean of Barthel Index between the group of M3 and BNM during admission and six months post discharge.

Results:

The mean total equipment cost of M3 was significantly higher than mean total equipment cost of BNM at p = 0.049 (mean difference of RM23.74) after controlling other variables. The mean difference in Barthel Index after six months was significant between the two groups (p = 0.031), patients who were treated with M3 had higher score [63.7 (SD 30.03)] compared to those who were treated with BNM [46.83 (SD 30.36)]. However, the cost-effectiveness ratio of using M3 was significantly lower (p=0.031) with a mean of RM476.29 needed for a unit improvement in mean Barthel Index compared to RM629.12 if we used BNM

Conclusion:

Although M3 is more costly, the outcome of patients treated with M3 was better than BNM. Therefore we can conclude that the used of multiple neuro-monitoring was more cost effective than the use of only baseline neuro-monitoring in treating severe traumatic brain injury.

Keywords: cost effectiveness analysis, severe traumatic brain injury, monitoring modalities.

CHAPTER 1

INTRODUCTION

The Global Burden of Disease Project has identified injuries as one of the ten causes of death and disability world wide (Murray & Lopez, 1997). The increasing importance of injury and non-communicable disease is particularly apparent in rapidly industrializing countries such as Malaysia where the profile of disease is changing (Baker *et al*, 1992, Berger & Mohan, 1996). Injuries and accidents are included as a 'disease' of importance in Malaysia recently. Injuries and accidents can occur at home, during recreation at work place or on the road. It is public knowledge that the road traffic accident rate is very high in Malaysia compared to most countries. Injuries have been among the top three and four causes of admission and death in government hospitals and the majority are road traffic accidents (Ministry Of Health, 2000). The figures have now exceeded 100,000 accidents per year involving 200,000 vehicles with peaks around public holidays such as Hari Raya and Chinese New Year holidays.

In 2001, 143,826 people were admitted to government hospitals for road traffic accidents and 2,404 died in the hospitals as a result of these injuries (Ministry of Health, 2001). Most of them are in the economically productive age group and many of them are maimed for life. Look at the mortality pattern due to injury, brain injury contributed 50.0% of total death (Kraus, 1993). The highest mortality was recorded for severe traumatic brain injury cases.

An injury or property damage as a result of an 'accident' is considered to be an economic loss since there is a net decrease in productivity or product to the nation. Traumatic brain injury accounts for almost one-half of all trauma fatalities and has a significant impact on mortality, morbidity, and health care cost (Max *et al*, 1990).One study estimated that the annual economic burden of traumatic brain injury in United State was approximately USD37.8 billion in 1985. This estimate included USD4.5 billion in direct expenditures for hospital care, extended care and other medical care and services, USD20.6 billion in injury-related work loss and disability, and USD12.7 billion in lost income from premature death (Max *et al*, 1991).. This study could not account for the intangible costs borne by families and friends of individuals who die prematurely from brain injury. For injured persons and their loved ones, the physical and emotional tolls from permanent disability are profound and impossible to quantify.

In Malaysia, there have been no previous data on economic loss due to injuries. Base on the per capital gross national product and a mean loss of life expectancy for a person killed in a road traffic accident, the Economic and Social Commission for Asia and the Pacific (ESCAP) calculated the cost of a fatality to be RM145,000 in 1983 (Arokiasamy & Krishnan, 1994).

Thus, traumatic brain injuries have a deep impact on the population and require a response from public health community to prevent these injuries and reduce consequent disabilities. To achieve the reduction in disabilities among patients with traumatic brain

injury, the Hospital USM has been working since 2000 to develop a neuro-surgical unit that can provide hospital care to all cases with traumatic brain injury.

The development of this unit involves with the recruitment of trained staffs, application of the specific equipments and setting up the rehabilitation unit.

Previously, the management of traumatic brain injury only focused in monitoring changes of the intracranial pressure (ICP). Even, in the previous study, it said that monitoring of ICP was used as a standard measurement tool to evaluate the progression of the patients (Bullock, Chesnut & Clifton, 1996). However, in the current situation, the services of neurosurgical unit of HUSM have been extended with application of multiple monitoring facilities like transcranial Doppler ultrasound, jugular venous oxygen monitor, arterial pressure monitor and others in managing patients with traumatic brain injury. Many researchers worldwide have investigated the benefit of using this equipment. Many of them agree that the implementation of multiple neuro-monitoring gave better outcome to the patients in term of reduction in physical disability and death (Schell & Cole, 2000, Tan *et* al, 2001). But, there was no study done previously to measure the cost-effectiveness of using this equipment.

The introduction of these new technologies may imply additional budget and staff time which, progressively, would lead to additional manpower requirements. With the limitation of the resources especially financial, a proper assessment like cost

effectiveness analysis needs to be carried out so that we can channel the resources in an appropriate manner.

Therefore, this study is designed to investigate the cost effectiveness of using multiple neuro-monitoring instead of using baseline neuro-monitoring that only provide limited information in managing severe traumatic brain injury. Since there was no documented such study done previously in Malaysia and lack of data about the effectiveness of using multiple neuro-monitoring as a standard tool, the results of this study will hopefully provide useful information for the policy maker to decide a proper decision in implementing new health technology equipments for the patients especially those who sustained severe traumatic brain injury.

CHAPTER 2

LITERATURE REVIEW

2.1. BRAIN INJURY

Brain injury covers a wide range of severity, from patients who die before admission to hospital to those with brain injuries so mild that they do not even come to hospital. In between are those in coma, either initially or as a result of complications (Asikainen, 2001). Brain damage after head injury can be classified by type and time course. The patterns of injury are separated into focal and diffuse injuries as shown in Table 1. In many patients, the distribution of lesions is multifocal like either multiple cortical contusions or multiple ischaemic lesions.

Table1. Lesions causing focal and diffuse patterns of damage after brain injury

Focal	Diffuse
Contusion	Axonal injury
Haematoma:	Hypoxia/ Ischaemia
Extradural	
Subdural	
Intracerebral	
Swelling	Diffuse vascular
Infarct	Fat embolism

Pressure necrosis	Subarachnoid haemorrhage
Haemorrhage	
Abscess	Meningitis

Source: Asikainen, 2001

In the time course, the differentiation can be made between primary damage, which develops at the moment of impact and secondary damage, which occur due to subsequent complications as listed in Table 2, which may be intracranial or systemic insults. Brain injuries can also be classified on the basis of mechanisms of injury; whether or not there is a compound fracture, an open or closed injury or missile or non-missile injury.

Table 2. Complications after head injury that cause secondary insults to damaged brain

Intracranial	**Systemic**
Haematoma	Hypoxia
Swelling	Hypercarbia
Raise intracranial pressure	Hypotension
Vasospasm	Severe hypocarbia
Infection	Fever
Epilepsy	Anaemia
Hydrocephalus	Hyponatraemia

Source: Asikainen, 2001

2.2 TRAUMATIC BRAIN INJURY

A traumatic brain injury occurs when an outside force impacts the head hard enough to cause the brain damage to move within the skull or if the force causes the skull to break and directly injury the brain. It can be classified as mild, moderate or severe (RPTBI, 1998). However it is not as simple as that. There are many different approaches to classify the severity of brain injury which can lead to much of the confusion, scientific, clinical and medico legal, that clouds discussion and fuel controversy. It is, therefore, important to obtain general agreement on the purpose of classification and must be made immediately after the injury (RPTBI, 1998).

The first purpose of classification of severity is for management in the acute stage, consisting of the patient's condition on arrival at hospital, how this is evolving, and what complications are possibly expected. The second is the potential for recovery after initial assessment and acute management. The third concerns the inter-relation between the injury and late sequelae, which may be due to both initial injury and the subsequent complications (RPTBI,1998).

Changes in consciousness are the basic of most approaches to classification of severity of the injury (Asikainen, 2001), and Glasgow Coma Scale score is most commonly used to classify the severity of injury (Lindsay & Bone, 1991).The Glasgow Coma (GCS) scale as shown in Table 3 is obtained from assessment of three parameters; eye opening, speech and motor response. In the severely injured the motor response is the most useful

component. The GCS is a widely accepted and understood scale; it allows early classification and ongoing reassessment of injury severity. In particular, its widespread acceptance allows succinct and accurate communication of injury severity between pre-hospital personnel, paramedical and medical staff. In general, a GCS of 13–15 indicates a mild injury, 9–12 a moderate injury, whilst 3–8 is classified as severe (http://www.biausa.org).

Around 80% of hospital admissions are for mild head injuries with only 5–10% being for severe injury (Jennett, 1996). GCS score is not only used to classify the severity of the injury but also can be used as a prediction scale to the outcome of the injury. Outcome prediction is of great importance in early management of severe head injury (Selladurai *et al*, 1992). Beside GCS scales, Marshall Classification System also commonly use in determining the severity of the injury that patient sustained as well as to predict the outcome of the illness based on cranial CT imaging (Selladurai *et al*, 1992). It consists of four categories (Table 4). Marshall *et. al.* (1992) reported that diffuse injuries with swelling or mid-line shift were significantly more likely to result in a patient classification of 'vegetative', while diffuse injuries (with no visible pathology) were likely to result in 'good outcome'.

2.2.1 Mild traumatic brain injury

Mild traumatic brain injury is a very common injury. Before 1991, mild traumatic brain injury was defined as an injury with an initial Glasgow Coma Scale of 13 to 15, post-trauma amnesia of less than 24 hours and a loss of consciousness of less than 20 minutes. In 1991 the definition was changed. According to the Mild Traumatic Brain Injury

Committee of the Head Injury Interdisciplinary special Interest Group of the American Congress of Rehabilitation Medicine, a patient with mild traumatic brain injury is a person who has a traumatically induced physiological disruption of brain function as manifested by at least one of the following (Kay *et al*, 1993):

1. Any period of loss of consciousness
2. Any loss of memory for events immediately before of after the accident
3. Any alteration in mental state at the time of the accident
4. Focal neurological deficit that may or may not be transient, but where the severity of the injury does not exceed the following:
    a. Post-traumatic amnesia not greater than 24 hours
    b. After 30 minutes, an initial GCS of 13-15
    c. Loss of consciousness of approximately 30 minutes or less

Table 3. Glasgow Coma Scale, coma score

ASSESSMENT	SCORE
EYE OPENING RESPONSE	
Spontaneously	4
To speech	3
To pain	2
None	1
BEST MOTOR RESPONSE (IN ARM)	
Obeys commands	6
Localization to painful stimuli	5
Normal flexion to painful stimuli	4

Spastic flexion to painful stimuli	3
Extension to painful stimuli	2
None	1
BEST VERBAL RESPONSE	
Oriented	5
Confused	4
Inappropriate words	3
Incomprehensive words	2
None	1

Source: Lindsay & Bone, 1991.

2.2.2 Moderate traumatic brain injury

There is no clearly demarcated clinical transition from mild to moderate traumatic brain injury (Alexander, 1995). According to Kibby and Long (1996), moderate traumatic brain injury is defined as a Glasgow Coma Scale score of 9-12 during the first 24 hours after the injury and post-traumatic amnesia lasting from 1 to 24 hours. Apart from that an injured person also can be grouped into moderate traumatic brain injury when his physical, cognitive and /or behavior impairments last for months or are permanent. They generally can make good recovery with treatment or successfully learn to compensate for their deficits (http://www.biausa.org).

2.2.3 Severe traumatic brain injury

Severe traumatic brain injury is defined as a Glasgow Coma Scale score of 8 or less during the first 24 hours after the injury (Thurman *et al*, 1996). It occurs when a prolonged unconscious state or coma lasts days, weeks, or months (http://www.biausa.org). The incidence of severe traumatic brain injury is lower than mild and moderate. Kraus and McArthur (1996) noted that the incidence of severe traumatic brain injury is between 5 and 25 percent of all cases with traumatic brain injury. In an epidemiological study of traumatic brain injuries that led to admission or death in Utah over a 3-year period, 16 percent of the hospitalized cases were considered to have severe traumatic brain injury and another 13 percent died before hospital admission (Thurman *et al,* 1996). Severe traumatic brain injury can be further categorized into subgroups with separate features (RPTBI, 1998):

1. Coma
2. Vegetative State
3. Persistent Vegetative State
4. Minimal Responsive State
5. Akinetic Mutism
6. Locked-in Syndrome

Individual who suffer severe traumatic brain injury are at risk for long-term disability. Their behavior can be disinhibited, egocentric, and disregarding of social conventions (RPTBI, 1998).

Table 4 Marshall Classification System (Base on cranial CT finding).

CATEGORY	DEFINITION
Diffuse Injury I	No visible pathology on cranial CT scan
Diffuse Injury II	Cisterns are visible with midline shift 0-5mm, and/or 1. Lesion densities present. 2. High or mixed density lesion present but 25ml in volume. 3. Bone fragment or foreign bodies present.
Diffuse Injury III	Cisterns compressed or absent with midline shift 0-5mm, no high or mixed density lesion > 25mL in volume.
Diffuse Injury IV	Midline shift >5mm, no high or mixed density lesions > 25mL in volume

Source: Marshall *et al*, 1991

2.3. CAUSES OF TRAUMATIC BRAIN INJURY

All reports all over the world show that the main causes of traumatic brain injury are road accident, falls and assaults. There is, however, considerable variation from place to place as shown in Table 5. The distribution of causes also varies greatly with the severity of injury, with road traffic accidents the dominant cause only for severe and fatal injuries. A study done in one of the state in Malaysia revealed that among the road traffic injuries most occurred in the evening and at nights (Moe, 2002). Pedestrians are apt to be more severely injured than vehicle occupants. Falls are a significant cause of brain injury, especially in young children and the elderly (RPTBI, 1998). Assault is a common cause of brain injury in some places, particularly in economically depressed and densely urban areas. Alcohol is an important contributory cause of injury and its influence is best documented in road traffic accidents, especially in drivers (Asikainen, 2001).

Table 5 Distribution (%) of causes of TBI in different places (Asikainen, 2001)

Place	Road traffic accident	Falls	Assaults
USA	49	28	NI*
Olmsted	47	29	4
Bronx	31	29	33
Australia	53	28	NI
Scotland	24	39	20
France	60	32	1
Spain	60	24	NI
Taiwan	60	5	NI
South Africa	74	8	38

Note: *No Information

Almost any sport or recreational activity can result in brain injury. In United State, some 10 percent of admissions for brain injury were related to sport or recreational activities (Whitman *et al.* 1984).

2.4. MANAGEMENT OF TRAUMATIC BRAIN INJURY

There is no universally accepted treatment plan for patients with severe traumatic brain injury. Management may be very complex with interaction of multiple variables such as intracranial pressure (ICP), cerebral perfusion pressure (CPP), arterial carbon dioxide tension (PaCO2) and mean arterial pressure (MAP) (Ghajar *et al*, 1995, Matta & Menon, 1996).

2.4.1. Management in the emergency room

The goal of initial assessment in emergency room is identification and simultaneous treatment of life-threatening injuries. The initial emphasis is on controlling the airway, ensuring adequate oxygenation and ventilation and correcting circulatory inadequacy. Neurological assessment, investigation and brain specific management should only follow once respiratory and cardiovascular stability are achieved. Early recognition and correction of hypoxia and hypotension is of critical importance as otherwise both mortality and neurological recovery may be adversely affected (Bullock, Chesnut & Clifton, 1996).

Patient with a severe head injury requires early tracheal intubation and ventilation with 100 percent oxygen until blood gas analysis is available. Unconscious patient with a head injury must be presumed to have cervical spine injury until has been excluded by clinical and radiological examination. The neck should be immobilized appropriately. Gastric dilatation may occur in any ventilated patient and large bore oro-gastric tube should be inserted to empty the stomach. Circulatory insufficiency should be corrected by rapid fluid replacement (Bullock, Chesnut & Clifton, 1996). In patient with severe traumatic brain injury, CT scanning is urgently indicated to detect an expanding intracranial haematoma (Marshall et al, 1991). Once the patient has been cardiopulmonary stabilized they will require referral to neurosurgical care unit for further management and most of the cases, surgical treatment will have taken place prior to this admission whereby an

intracranial pressure-monitoring device will have been inserted (Bullock, Chesnut & Clifton, 1996).

2.4.2. Neuro-Monitoring for Traumatic Brain Injury

The primary goal of management for traumatic brain injury is the prevention of secondary damage due to neuronal hypoxia and hypoperfusion (Chamber & Mendelow, 1997). Monitoring modalities are aimed at identifying potential episodes of hypoxia and guiding therapy related to cerebral perfusion (http://www.trauma.org). Standard monitoring for all such patients is required including oxygen saturation (SaO2), electrocardiography (ECG), mean arterial blood pressure (MAP) and urine output. These patients will require frequent determination of arterial blood gases and intra-arterial catheter is helpful. Patients are maintained euvolaemic and central venous pressure measurements are used to guide therapy. Normocapnia is vital for maintenance of intracranial pressure (ICP), and patients should have continuous measurement of end-tidal carbon dioxide (CO2) level using a capnometer. These represent the baseline requirements for monitoring of these patients (http://www.trauma.org). Patients receiving inotropic agents to increase MAP and maintain cerebral perfusion pressure may benefit from pulmonary artery occlusion catheters to guide therapy (Obrist *et al*, 1984).

2.4.2.1 Intracranial Pressure Monitoring (Baseline Neuro-Monitoring)

Cerebral perfusion pressure is maintained by supporting mean arterial pressure and / or reducing intracranial pressure. The most accurate and reliable method of monitoring intracranial pressure is with an intraventricular catheter connected to a pressure transducer. This system also allows intermittent drainage of cerebrospinal fluid from the ventricles to aid in control of ICP. Manometer type systems allow re-calibration whereas fiberoptic devises may suffer from baseline drift if used for several days. Catheters may also be placed in the cerebral parenchyma, or the subdural and subarachnoid spaces. While easier to insert in some cases these may not accurately measure the ICP when compared to an intraventricular catheter. Epidural devises are significantly less accurate (http://www.trauma.org).

In general complications related to ICP monitoring are rare. However, bacterial colonization does occur (5% ventricular/subarachnoid, 15% parenchymal), and its incidence increases markedly after 5 days in situ. Irrigation ICP devises significantly increases the risk of colonization. Treatment is removal of the ICP bolt. It is difficult to assess the risk of haematoma formation associated with ICP monitors but the rate is 1.4% with 0.5% requiring surgical evacuation. Parenchymal catheters have a higher incidence of hematoma than other methods. Malfunction of the devises does occur, and readings over 50 mmHg may be inaccurate with higher rates of obstruction and loss of signal (http://www.trauma.org).

2.4.2.2. Multiple Neuro-Monitoring Techniques

While maintenance of cerebral perfusion pressure (CPP) is important, it only measures one parameter affecting the delivery of oxygen to the neurons. Ultimately, the Cerebral Blood Flow (CBF) and oxygen content of the blood are the prime parameters. CPP provides a pressure gradient governing CBF, but flow is affected by the resistance of the cerebral vessels. Neurons with high activity levels required greater amounts of oxygen than those which are quiescent (http://www.trauma.org). Thus monitoring only the ICP and CPP really gives very little idea of the overall state of the injured brain and no idea at all about oxygen delivery and usage. Multiple neuro-monitoring allows using a combination of jugular venous bulb oximetry and transcranial Doppler ultrasound allows a greater understanding of the state of the cerebral circulation and oxygen consumption (Schell *et al*, 2000, Tan *et al*, 2001).

2.4.2.2.1 Jugular Venous Bulb Oximetry

Jugular venous bulb oximetry involves placing a sampling catheter in the internal jugular vein, directly upwards, so that its rest in the jugular venous bulb at the base of the brain. It is often performed in conjunction with other monitoring and imaging techniques and provides early detection of cerebral ischemia that might otherwise go unrecognized (Schell *et al*, 2000). It uses to measure the mixed venous oxygen saturation (SjO2) of blood leaving the brain. The SjO2 will fall when there is an imbalance between oxygen

consumption and delivery. If SjO2 falls bellow 50%, this implies either a fall in CBF or a rise in oxygen utilization (http://www.trauma.org). From the previous studies, it stated that despite of the limitation of using jugular venous bulb oximetry like the need of expert hand and expansive equipment, there is no better, commercially available, continuous, bedside monitor to assess the adequacy of cerebral oxygenation. Jugular venous oxygenation provides information on global brain oxygenation and is recommended in the treatment of patients with head injury, especially that receiving hyperventilation therapy (Schell *et al*, 2000, Imberti *et al*, 2002).

2.4.2.2.2 Transcranial Doppler Ultrasound

Transcranial doopler is a non-invasive method of assessing the state of the intracranial circulation (Tan *et al*, 2001). Doppler waveform analysis can give further information about the state of blood flow, such as flow acceleration and pulsatility index. Low velocities in the intracranial circulation after head injury are due to low cerebral blood flow and high ICP levels. Low velocities on admission are indicative of a poor prognosis. A reduction in CPP and rise in ICP are also reflected in a rise the pulsatility index. Transcranial doopler also is useful for monitoring at-risk patients for signs of vasospasm. Vasospasm is common after head injury and can be an important cause of neurologic deterioration (http://www/trauma.org). In the previous study, it shown that transcranial doopler can demonstrate a high degree of sensitivity in predicting the outcome of severely traumatic brain injured patients and it was indicated for patients who had

intracranial hypertension and cerebral perfusion pressure that cannot be maintained by standard therapy (Tan *et al*, 2001).

2.4.3. Assessment of the outcome of patients with traumatic brain injury

Successful outcome for the traumatically brain injured patient is dependent on both a productive clinical therapy program and an effective case- management strategy by the carrier. Generally, recovery following brain injury is greatest over the early months after the injury, with rate of improvement then declining rapidly. In the weeks or months after a severe traumatic brain injury, the patient may remain bedfast or dependent on total care before recovering to a level where active rehabilitation is possible. In people with severe traumatic brain injury, improvement is very much slower than this and continues for considerably longer. They may take at least six months to twelve months to show some physical improvement (Ashely & Krych, 1990). There are many ways to assess the outcome of patient following severe traumatic brain injury. Some researchers like to use Glasgow Outcome Scale (GOS) score to predict outcomes, some prefers to use Disability Rating Scale (DRS) score. According to Whyte and Rosenthal in 1998, GOS had a lot of weakness in providing detailed information regarding a patient's functional ability and level of independence. In describing the outcome categories, Jennett and Bond (1975) had provided global indicators of level of independence, but these scales are not detailed enough to differentiate between the resultant living situations of many survivors of traumatic brain injury. For example, "good recovery" is identified by a resumption of normal life, even though there may be minor neurological and pathological deficits.

Patients achieving a "moderate recovery" are classified as "disabled but independent", characterized by "independence in daily life", and "independence which is greater than simple ability to maintain self-care within the home". "Severe disability" is characterized by dependence for daily physical support by reason of mental and/or physical disability.

Apart from GOS and DRS, the Barthal Index scoring system also can be used to assess the outcome the patients with severe traumatic brain injury. This scoring system was more comprehensive and had been recommended as a standard measure of physical disability to those who had neurological deficit (Laura *et al*, 1998).

Barthel Index has been used since 1955, to score the ability of a patient with a neuromuscular or musculoskeletal disorder to care for himself, and by repeating the test periodically, to assess his improvement. It is a simple index score that contain ten items which are related to physical activities that are needed to be performed by the patient (Appendix 3). The value assigned to each item are based on time and amount of actual physical assistance required if a patient is unable to perform the activity. Full credit is not given for an activity if the patient needs even minimal help and/or supervision. The maximum score is 100 and the minimal score is 0. The Barthel Index has also been taught to many nurses, who have been helpful in evaluating patients prior to admission and after discharge (Mahoney & Barthel, 1965). Because of its comprehensiveness and easy to conduct and analyse, the Barthel Index scoring system was used in this study as an outcome assessment.

Definition And Discussion Of Barthel Index Scoring System (Mahoney and Barthel, 1965)

1. Feeding
    a. 10 marks are given to a patient if he can feed himself a meal from a tray or table when someone puts the food within his reach. He must put on an assistive device if this is needed, cut up the food, use salt and pepper, spread butter, etc. He must accomplish this in a reasonable time
    b. 5 marks are given to a patient if he needs some help.
2. Moving from wheelchair to bed and return
    a. 15 marks are given to a patient if he independently does these activities. Patient can safely approach the bed in his wheelchair, lock brakes, lift footrest, move safely to bed, lie down, come to a sitting position on the side of the bed, change the position of the wheelchair, if necessary, to transfer back into it safely, and return to the wheelchair.
    b. 10 marks are given to a patient if he either needs minimal help or need to be reminded or supervised for safety of one or more parts of this activity.
    c. 5 marks is given to a patient if he can come to sitting position without help of second person but need to be lifted out of bed, or if he transfers with a great deal of help.
3. Doing personal toilet

a. 5 marks is given to a patient if he can wash hands and face, comb hair, clean teeth and shave. He may use any kind of razor but must put in blade or plug in razor without help as well as get it from drawer or cabinet. Female patients must put on own makeup, if used, but need not braid or style hair.

4. Getting on and off toilet
    a. 10 marks are given to a patient if he is able to get on and off toilet, fasten and unfasten clothes, prevent soiling of clothes, and use toilet paper without help. If it is necessary it use bed pan instead of toilet, he must be able to place it on a chair, empty it and clean it.
5. Bathing self
    a. 5 marks are given to a patient if he is able to do all the steps involved in bathing.
6. Walking on a level surface
    a. 15 marks are given to a patient if he can walk at least 50 yards without help or supervision. He may wear braces or prostheses and use crutches, canes, or a walkerette but not a rolling walker.
    b. 10 marks are given if the patient need help or supervision in any of above but can walk at least 50 yards with a little help.
7. Propelling a wheelchair (part of item 6)
    a. 5 marks are given to the patient who is cannot ambulate but can propel a wheelchair independently. He must be able to go around corners, turn

around, maneuver the chair to a table, bed, toilet, etc. he must able to push a chair at least 50 yards.

8. Ascending and descending stairs
    a. 10 marks are to the patient if he able to go up and down a flight stairs safely without help or supervision. He may and should use handrails, canes, or crutches when needed.
    b. 5 marks are given if the patient needs help with or supervision of any one of above items.
9. Dressing and undressing
    a. 10 marks are given if patient is able to put and remove and fasten all clothing, and tie shoe laces. The activity includes putting on and removing and fastening corset or braces when these are prescribed.
    b. 5 marks are given to the patient if he needs help in putting on and removing or fastening any cloth. He must do at least half the work himself. He must accomplish this in a reasonable time.
10. Continence of bowels
    a. 10 marks are given to the patient if he is able to control his bowel and have no accidents. He can use a suppository or taken an enema when necessary.
    b. 5 marks are given to the patient who need helping using a suppository or taking enema or has occasional accidents.

11. Controlling bladder

a. 10 marks are given to the patient who is able to control his bladder day and night.

b. 5 marks are given to the patient if he has occasional accidents or can not wait for the bed pan or get to the toilet in time or needs help with an external device.

2.5. COST FOR MANAGING THE TRAUMATIC BRAIN INJURY PATIENT

In the past ten years, there has been much progress in the management of the traumatic brain injury patient. Development of the new and expensive equipment has improved the final outcome of the patient with traumatic brain injury. The presence of the skillful and expert personnel, guides the treatment toward the better quality of life of the patient. However, this will either directly or indirectly increase the total cost of the management of the patient. Mayer *et al.* (2003), found out that the biggest differences in individual bills occurred during the first week of treatment. During this time, costs for medical and surgical supplies were greatest for persons with severe brain injuries and those who eventually spent longer time in the Neuro-Intensive Care Unit. Additionally, individuals with more severe injuries received the highest pharmacy bills. Bills differed among individuals, and it appeared that those who received the highest charges tended to be older, required more medical services and spent more days in the ward.